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The usefulness of perioperative bronchoalveolar lavage in thoracic surgery

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Abstract
Objective: *Lung infection post thoracic surgeries are one of the most common complications that can lead to an increase in the length of hospital stay. We aimed to investigate whether perioperative bronchoalveolar lavage can decrease post operative lung infection.*
Methods: *This is a retrospective study including 194 patients who underwent different thoracic surgeries at single site from June 2013 to March 2020. Patients were divided into two groups. The first group is the standard group included 94 patients , while the second group included 100 patients who had perioperative bronchoalveolar lavage. Data were collected from patient's files.*
Results: *The bronchoalveolar lavage group (n=100) had a significantly lower incidence of postoperative lung infection (11%) compared to the standard group (22.3%) P-value =0.033. Also, the length of hospital stay was significantly shorter in the bronchoalveolar lavage (5.6 days) compared to the standard group (9.4 days) P-value =0.000. Moreover, the bronchoalveolar lavage showed a useful diagnostic when (73%) of patients who developed chest infection had a positive culture from the bronchial washing.*
Conclusion*: Bronchoalveolar lavage may decrease the risk of post-operative chest infection. As a result, decrease the length of hospital stay. Also, it can use as diagnostic methods to treat patients with a chest infection. But further studies needed to confirm our results.*
Key Words: *Bronchoalveolar lavage, Chest infection, Thoracic surgery.*

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I. Introduction:

Lower respiratory tract infection (LRTI) after thoracic surgeries considers one of the most common complications (15%-20%). As a result, the infection can increase the morbidity and mortality rate to19%-40%, Also that can lead to postponing the adjuvant treatment if indicated and increase the length of hospital stay (LOS).[1,2]Many factors can increase the risk of post-operative chest infection such as smoking, lung disease, post-operative pain, the volume of resection, surgical approach (open vs minimal invasive),etc.[3-5]

Many articles addressed the best way to decrease the risk of post-operative chest infection.[6] In addition to traditional precautions such as smoking cessation, postoperative early mobilization, decrease intraoperative intravenous fluid administration, etc.[7-10]However, there is little in regard perioperative bronchoalveolar lavage (BAL) to decrease the chest infection rate in thoracic surgeries.

Lower respiratory tract infection after thoracic surgery can be related to many factors, such as post-operative pain which leads to decrease coughing. As a result, that leads to accumulating the secretions and sputum which lead to a chest infection. Additionally, bronchial colonization one of the risk factors for chest infection after lung resection.[11,12]

We aim in this study to evaluate the benefit of perioperative bronchoalveolar lavage (BAL) and the effect on post-operative chest infection and how it can reflect on the length of hospital stay (LOS).

II. Methods:

This is a retrospective study including 194 patients who underwent different thoracic surgeries in St.Vincent University Hospital from June 2013 to March 2020. Patients were divided into two groups. The first group is the standard group included 94 patients, while the second group included 100 patients who had perioperative bronchoalveolar lavage.

Chest infection was diagnosed based on clinical features, blood tests, imaging, and culture results of BAL samples. On the other hand, LOS was calculated from the day of admission and without calculation the discharge day. Data were collected from patient's files.

Procedure:

Perioperative flexible bronchoscopy was performed during anesthesia and single-lumen endotracheal intubation immediately before double lumen placement and the surgical procedure. An inspection of the bilateral bronchial tree to evaluate for any endobronchial lesion, tumor invasion, or secretion was performed. Then a 50cc of normal saline was injected in each side and aspirated again. Accordingly, two samples from each side were sent for laboratory analysis, one as a cytology analysis, and another one for microbiology analysis. Moreover, suctioning of any secretions in the bronchial tree was done in the procedure.

This procedure was done by the cardiothoracic consultant or the registrar and it takes around 5-10minutes.

Statistical analysis:

A comparison between group 1 and group 2 and Patients' demographic and disease information was carried out using the Chi-square test, Fisher exact depending on the assumption required for each test, and differences in continuous variables were tested with a student t-test.

Multivariate analysis was done for the significant factor by using logistic and linear regression analysis. A significance criterion of $p <= 0.05$ was used in the analysis. All analyses were performed using SPSS.

III. Results:

Between June 2013 and March 2020, 194 patients underwent different thoracic surgeries for primary or secondary lung cancer, benign lung diseases, chest wall resection, and thymic resection. First group(n=94) patients who had not BAL perioperatively, of these, there were 40 (42.5%) male, 54 (57.5%) female, and the mean age is 66.5 years old. The second group (n=100) patients who had BAL perioperatively. The mean age of the second group is 61 years old. Out of these, there was 40 (40%) male and 60 (60%) female.Tab.1

Patients with a smoking history or active smokers were (68%) in the first group vs (56%) in the second group. Additionally, open procedures were performed in the first group (63%) comparing to (16%) in the second group. While minimally invasive procedures (robotics and video-assisted) were performed(37%)in the first group compared to(84%)in the second group. Tab.1

The bronchoalveolar lavage group (n=100) had a significantly lower incidence of postoperative lung infection (11%) compared to the standard group (22.3%) P-value = 0.033. Also, the length of hospital stay was significantly shorter in the bronchoalveolar lavage (5.6 days) compared to the standard group (9.4 days) P-value= 0.000. Tab.1 Patients characteristics and type of surgery all are prescribed in Tab.1.

Regarding chest infection, we did a univariate analysis of different factors that may be related to a postoperative chest infection. As a result, the lung disease, surgical approach, and the groups (using BAL perioperatively) were significantly related to chest infection with P value (0.034, 0.029, 0.033)respectively.Tab.2

Accordingly, we did a multivariate analysis of these factors (perioperative bronchoscopy, surgical approach, and lung disease). The perioperative bronchoscopy and absent lung disease showed a decreased risk of a chest infection but not statistically significant on multivariate analysis. Moreover, the minimally invasive approach (VATS, RATS) showed less risk of chest infection comparing to an open approach but also without significant P-value. Tab.3

On the other hand, lung disease and groups were analyzed in correlation to LOS by linear regression as multivariate analysis. Interestingly, both were statistically significant in correlation with decreasing the LOS(P-value.014and0.000) respectively.(Tab.4)

Regarding the diagnostic value of perioperative bronchoscopy, we reviewed the 100 patients in that group and analyzed the results of the culture test and post-operative chest infection. Out of 100patients, 11% had a chest infection. Moreover, out of this 11 %, there was a positive culture test in 73% of them which is a high diagnostic value. Patient's characteristics and culture results described in (Tab.5). Also, 69.2% of patients who had positive culture didn't get chest infection postoperative.

IV. Discussion:

One of the causes of a chest infection after thoracic surgery is the inability of the patient to clear airway secretion which leads to decrease patency of the airway and increases the risk of respiratory failure.

Many factors can induce this condition, such as postoperative pain which correlated to the surgical approach, patient condition, and previous lung diseases, volume of lung resection, etc. Accordingly, one of the most important prophylactic procedures which can be done is the airway suctioning.[13-15]

A prospective cohort study by Belda et al. pointed to assess the association between airway colonization in the

BAL samples and the frequency of postoperative chest infection. Their study involved 78 patients and 83% of patients had airway colonization. Postoperative chest infection was recognized in 24 patients (31%). They concluded that postoperative chest infection can be reduced by controlling the causes of airway colonization.[16] Moreover, Oor et.al did a retrospective study that included 121patients who had open lung resection for lung cancer. They evaluated the relationship between positive intra-operative bronchial culture and post-operative lung infection. They found that 88% of patients with a positive culture developed a lung infection during the recovery period. The multivariate analysis revealed that the positive culture is an independent risk factor for the development of lung infection postoperatively.[17]

These results were similar to our results which showed that the existence of perioperative airway colonization by bacterial microorganism are independent predictors of postoperative respiratory infection. On the other hand, when 69.2% of patients who had a positive culture did not get a postoperative chest infection. That is another proof for the benefit of perioperative BAL and suctioning the secretions which decrease the risk of chest infection.

Amir et al. did a clinical trial on role of BAL and flexiable bronchoscopy to prevent pneumonia in ICU patients. Trial was conducted on 67 head-injury patients who needed tracheostomy. The eligible patients were divided into two groups of different methods for removing the airway secretions. In intervention group, flexible bronchoscopy and BAL was added to routine conventional methods for airway clearance. In results they founded that the risk of pneumonia decreased from 35% to 14% in intervention group. The days of hospital stay were significantly reduced with bronchoscopic method.[18]

The above-mentioned article can support our study the clearance the airway secretion, especially in high-risk patients may prevent and decrease the postoperative chest infection. While our approach is less invasive and more practical and gave the same results as showed in our results.

The focus of this study that is discusses the utility of perioperative bronchoscopy as a prophylactic procedure to prevent postoperative chest infection in thoracic surgeries. Our results show that this approach decreases the risk of infection and the length of hospital stay. Moreover, it is not a time-consuming procedure and provide important airway assessment.

We demonstrate the value of bronchoscopy and BAL microbiology assessment and recommend the approach. Patients given a thorough clearance prior to a period of prolonged single lung ventilation may prevent positive pressure delivery and peripheral dispersal of airway sections. This may contribute to the subsequent reduction in airway infections seen. The performance of bronchoscopy in all thoracic cases has other core advantages in regard to surgical anatomy and airway assessment. Having a BAL sample in the laboratory which is positive for infection also identifies the problem early and allows sensitivity and specificity testing. We are not advocating starting anti-microbial therapy on the basis of an isolated BAL in an otherwise well patient. However, if a patient subsequently demonstrates clinical, hematological, and radiological signs of infection, the early result from the peri-operative BAL sensitivities and specificities may assist in targeting therapy.

Occasionally the drive for efficiency and pressure on surgery volumes can motivate to elect not to perform a bronchoscopy. Bronchoscopy in the COVID-19 era has been classed as an aerosol-generating procedure. This has raised the threshold for performing this procedure in tandem with thoracic surgery. In this study, we see that although there may be are short term time equipment and laboratory costs, there is a patient benefit that may not be apparent in the operating room as it accrues over the following days.

The limitation of this study is the retrospective non-matching method, which needs to make in future further studies to confirm our results. The study is not randomized and on univariate analysis surgical approach was difference between two groups. However on multivariate analysis the significant difference In LOS presented in dependent on surgical approach. Further studies are needed to confirm our results.

V. Conclusion:

The bronchoscopy part of thoracic surgery may decrease the risk of post-operative chest infection. And useful in microbiology assessment in a chest infection. And decrease the length of hospital stay as shown in the multivariate analysis.

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Name	Value	Non-bronchoscopy group I(n=94)	Bronchoscopy group II (n= 100)	P-value
Sex	M F	40(42.5%) 54(57.5%)	40(40%) 60(60%)	0.718
DM	Yes No	9(9.5%) 85(90.5%)	9(9%) 91(91%)	0.890
HTN	Yes No	43(45.5%) 51(54.5%)	22(22%) 78(78%)	0.000
IHD	Yes No	15(16%) 79(84%)	7(7%) 93(93%)	0.049
Lung disease	Yes No	32(34%) 62(66%)	23(23%) 77(77%)	0.088
Smoking	Yes + ex No	64(68%) 30(32%)	56(56%) 44(44%)	0.083
Type of Surgery	Open VATS RATS	59(63%) 33(35%) 2(2%)	16(16%) 72(72%) 12(12%)	0.000
Volume of resection	Wedge resection Lobectomy Pneumonectomy Thymectomy Chest wall resection Pleurectomy	21(22.5%) 64(68.1%) 4(4.2%) 2(2.1%) 2(2.1%) 1(1%)	45(45%) 48(48%) 1(1%) 3(3%) 2(2%) 1(1%)	0.007
Stage	Benign I II III Metastasectomty Thymoma Chest wall tumor Pneumothorax	9(9.5%) 58(63.1%) 10(11.5%) 6(6.5%) 4(4.2%) 2(2.1%) 2(2.1%) 1(1%)	30(30%) 33(33%) 6(6%) 7(7%) 18(18%) 3(3%) 2(2%) 1(1%)	0.000
Chest infection	Yes No	21(22.3%) 73(77.7%)	11(11%) 89(89%)	0.033
Mean Age		66.5	61	0.001
Mean LOS		9.4	5.6	0.000

Table1-patients characteristics and results.

name	value	Total	**Chest infection**		P-value
			No	Yes	
Age			63	57	0.065
Lung disease	Yes	55	41	14	0.034
	No	139	121	18	
Smoking	No	74	64	10	0.303
	Yes	120	98	22	
groups	group1	97	73	21	0.033
	group2	100	89	11	
Surgical approach	Open	75	56	19	0.029
	VATS	105	94	11	
	RATS	14	12	2	
Type_of_Surgery	Wedge resection	66	61	5	0.060
	Lobectomy	112	88	24	
	Pneumonectomy	5	3	2	
	Thymectomy	5	5	0	
	Chest wall resection	4	3	1	
	Pleurectomy	2	2	0	
stage	Benign	39	35	4	
	I	91	72	19	
	II	16	12	4	
	III	13	11	2	0.600
	Metastasectomty	22	20	2	
	Thymoma	5	5	0	
	Chest wall tumor	4	3	1	
	Pneumothorax	2	2	0	

Table2_chest infection – Univariate analysis(N=194)

Logistic binary regression

	B	Wald test	Exp (odd ratio)	**P value**	R^2
Group(bronchoscopy)	-0.411	0.766	0.663	0.381	
Surgery		3.358		0.187	0.096
Surgery(open)	0.850	3.349	2.341	0.067	
Surgery(Vats)	0.412	0.239	1.509	0.625	
Lung disease(NO)	-0.752	3.358	0.472	0.067	
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Table3-Multivariate analysis by logistic regression.

Reference category . DV = chest infection (yes) , surgery (RATS) , group (non- bronchoscopy) , Lung disease(yes)

Model	Unstandardized Coefficients		t	**P value**
	B			
1				
Lung disease	2.155		2.474	.014
Group	3.496		4.450	.000

Table4-multivariate analysis for LOS using Multiple linear regression

a.Dependent Variable: LOS

Name	Value	Total(11 patients)
Sex	MF	3(27%) 8(73%)
DM	Yes No	3(27%) 8(73%)
HTN	Yes No	4(36%) 7(64%)
IHD	Yes No	1(9%) 10(91%)
Lung disease	Yes No	3(27%) 8(73%)
Smoking	Yes+ex No	6(54%) 5(46%)
Type of Surgery	Open VATS RATS	3(27%) 8(73%) 0
Type of resection	Wedge resection Lobectomy Pneumonectomy Thymectomy Chest wall resection	5(45.5%) 5(45.5%) 0 0 1(9%)
Stage	Benign I II III Metastasectomty Thymoma Chest wall tumor	4(36%) 1(9%) 2(18.5%) 1(9%) 2(18.5%) 0 1(9%)
Culture results	Positive Negative	8(73%) 3(27%)
Pus cells	Positive Negative	7(63.5%) 4(36.5%)
Pre-operative WBC+ Neutrophils	Normal Elevated N\A	10(91%) 0 1(9%)
Pre-operative CRP	Normal Elevated N\A	4(36.5%) 3(27%) 4(36.5%)

Table5– patient with chest infection characteristics.

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